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Remarks

Claims 1-12 are currently pending in the present patent application, with claim 13 having been cancelled through the above claim amendments. Claim 1 has been amended to more particularly point out and distinctly claim the recited subject matter. This amendment does not narrow the scope of claim 1.

In a final Office Action mailed 5 June 2006, the Examiner maintained the rejections of claims 1-6, 9, and 11-12 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent Application Publication No. 2002/0164523 to Shibata *et al.* ("Shibata"). Claims 7-8 and 10 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Shibata in view of U.S. Patent Application Publication No. 2002/0028367 to Sammes *et al.* ("Sammes").

On September 7, 2006, the undersigned along with the inventor Partho Sarkar and Brian Y. Lee, Canadian counsel for the assignee of the present application, held a telephone interview with the Examiner to discuss the rejections of the pending claims. As set forth in the Examiner's Interview Summary mailed September 12, 2006, no agreement was reached as to the allowability of any of the claims. More specifically, with regard to claim 1, the Examiner contends that the alumina ceramic of the Shibata reference corresponds to the porous ion-conducting structure recited in claim 1. See page 3 of the Interview Summary. The Examiner contends that even if the alumina ceramic is considered in the prior art as an insulating material, this material is nonetheless capable of conducting some ions, even if such ion conductivity is poor. *Id.* The Examiner requested objective evidence to support that such an alumina ceramic is "incapable" of transporting ions, meaning that the material exhibits no ion conduction at all. *Id.* During the interview, the Examiner also raised what he termed a potential 35 U.S.C. § 112, paragraph 1, issue regarding the recitation of an ion-conducting structure in the claims and pointed to paragraph 19 of the specification to support his assertion that only a description of oxygen ion conducting materials is contained in the application.

In order to help the Examiner appreciate certain distinctions between the pending claims and the subject matter of the applied references, a disclosed embodiment of the invention will now be discussed in comparison to the applied references. Specific distinctions between the pending claims and the applied references will be discussed after the discussion of the disclosed embodiment and the applied references. This discussion of the differences between the disclosed embodiment and applied references does not define the scope or interpretation of any of the claims.

Embodiments of the present invention are directed to an anode-supported solid oxide fuel cell (SOFC) including an anode support layer. A suitable material for the anode support layer (ASL) is yttria stabilized zirconia (YSZ). See, e.g., paragraph 8 of the present application. YSZ is an excellent conductor of negatively charged oxygen (oxide) ions at high temperatures. See paragraph 3. A SOFC operates at an elevated temperature, typically in the order of between 700-1000 °C. *Id.* YSZ is a solid oxide electrolyte and an oxygen ion conductor suitable for use in a SOFC. See, e.g., page 101 of the Suresh publication, which accompanies this amendment as Attachment 1. Other oxygen ion conducting materials suitable for use in a SOFC may be substituted for YSZ in the anode support layer. See paragraph 19. A characteristic of a solid electrolyte, which may otherwise be known as a fast ion conductor or a superionic solid, is a high electrical conductivity in the range of 10^{-1} - 10^{-4} ohm⁻¹ · cm⁻¹ (i.e. a resistivity of 10-10,000 ohm · cm). See page 17 of Attachment 1. In contrast, alumina (aluminum oxide) has a resistivity of 5.0×10^8 at 700°C and 2×10^6 at 1000°C (see page 959 of the Shackelford and Alexander publication, which accompanies this amendment as Attachment 2) and thus is not a solid electrolyte/fast ion conductor/superionic solid suitable for SOFC use. See also the article that accompanies this amendment as Attachment 3 for additional information regarding resistivity and the listing of Web sites in Attachment 4 that illustrate alumina being used as an insulator.

Turning now to the Shibata patent, the Examiner points to paragraph 69 of Shibata as disclosing an SOFC unit cell having a porous base body 1 which

includes a ceramic (alumina) body plated with Ni, an electrode 10, an electrolyte 12, and an electrode 11. The base body 1 material (alumina) simply cannot be considered a porous oxygen ion conducting structure suitable for solid oxide fuel cell use. As shown in accompanying samples of scientific literature, alumina's resistivity is too high for this material to be considered a solid electrolyte and an oxygen ion conductor suitable for use in a SOFC. In order for a material to be considered an oxygen ion conductor suitable for SOFC use in an electrode, the material must provide the necessary and efficient ionic path for anodic reaction which takes place during SOFC operation. As is well known in the SOFC art, the ionic conductivity of the anode must be comparable to the ionic conductivity of the electrolyte, and thus alumina's resistivity is also too high at SOFC operating temperature to carry out SOFC electrode function.

The Examiner cannot contend that because alumina must exhibit some ion conductivity, the base body 1 of Shibata may be considered to correspond to the anode support layer of the present application. Materials are classified as having physical characteristics that result in each material being placed in a particular class of materials, such as an electric or thermal conductor or insulator or an ionic conductor or insulator. Materials are not classified in absolute terms as is suggested by the Examiner. The Examiner requests evidence that "ceramic alumina is INCAPABLE of transporting ions (no ion conduction at all)." See page 3 of the Interview Summary. No such evidence can be provided for any material. Although classified as a particular type of material, every material will exhibit some characteristics of another class of materials. For example, materials classified as electrical insulators exhibit some amount of electrical conductivity, but such conductivity is so small that these materials are nonetheless classified as insulators. If the Examiner's argument was accepted, then the classification of materials would be rendered pointless. Any material could be said to be whatever type of material was needed by an Examiner when formulating a rejection.

Pursuant to MPEP § 2111, during patent examination the pending claims must be given their broadest reasonable interpretation consistent with the

specification. The Examiner expressly mentioned this well known tenet of patent examination. As expressly set forth in Section 2111, the "broadest reasonable interpretation of the claims must also be consistent with the interpretation that those skilled in the art would reach." As evidenced by the accompanying technical literature, as well as the comments of the inventor Partho Sarkar during the telephone interview with the Examiner, one skilled in the art would not interpret the phrase "ion-conducting structure" to include the insulating material of alumina ceramic. The Examiner's attempt to so interpret this phrase is simply put an unreasonable interpretation of this language. Although the Examiner cites the "broadest reasonable interpretation" language of Section 2111 as the rationale for his interpretation, such an interpretation of this language plainly in violation of this section of the MPEP as well as in contravention of common sense.

Now turning to the claims, amended claim 1 recites an anode-supported solid oxide fuel cell including an anode support layer. The anode support layer includes a porous oxygen ion-conducting structure suitable for solid oxide fuel cell use and having pores impregnated with a catalytic and electronically conductive material. An electrolyte layer is in adjacent intimate contact with the anode support layer and a cathode layer is in adjacent intimate contact with the electrolyte layer.

Shibata neither discloses nor suggests an anode support layer as recited in amended claim 1. The base body 1 of Shibata simply cannot be said to correspond to the recited anode support layer. As discussed above, an alumina ceramic as set forth in paragraph 69 of Shibata simply is not "a porous oxygen ion-conducting structure suitable for solid oxide fuel cell use." Because an alumina ceramic exhibits some ion conductivity does not make such an alumina ceramic an ion-conducting structure. As previously discussed with reference to the attached technical literature, alumina's resistivity is too high for this material to be considered a solid electrolyte and an oxygen ion conductor suitable for use in a SOFC. Such an alumina's resistivity is also too high at SOFC operating temperatures to carry out the function of an SOFC electrode.

Furthermore, claim 1 recites an electrolyte layer in intimate contact with the ASL. Shibata discloses electrodes 10 and 11 to be in intimate contact with the electrolyte, and neither electrode 10, 11 of Shibata corresponds to the structure of the ASL as recited in claim 1, i.e. a porous oxygen ion conducting structure suitable for SOFC use and having pores impregnated with a catalytic and electronically conductive material. Although the Examiner suggests that the porous base body 1 in Shibata discloses the ASL as presently claimed, such base body is not in intimate contact with the electrolyte, nor can the base body material (alumina) be considered a porous oxygen ion conducting structure suitable for solid oxide fuel cell use.

For all these reasons, the combination of elements recited in amended claim 1 is allowable. Dependent claims 2-11 are allowable for at least the same reasons as claim 1 and due to the additional limitations added by each of these claims.

It should be pointed out that amended claim 1 now expressly recites that the anode support layer includes a "porous oxygen ion-conducting structure." Support for this is found, for example, in paragraph 12 of the application. This amendment should render moot any potential Section 112 issues alluded to by the Examiner in the Interview Summary. See page 3 of the Interview Summary. These comments are not meant to indicate that the undersigned agrees there ever were any Section 112 deficiencies with the prior claim language. Also note that this amendment in no way necessitates a new search by the Examiner since, as admitted by the Examiner, the prior language could have been construed to include any type of ion-conduction structure so surely the prior search included oxygen ion-conducting structures. The same is true of the amendment that the oxygen ion-conducting structure is "suitable for solid oxide fuel cell use." This amendment merely expressly recites what was implicit before and is in direct contrast to the structure and function of the relied upon components in Shibata, which are not suitable for solid oxide fuel cell use." The same is true for the amendments of claim 12, which will now be discussed in more detail below.

Amended claim 12 recites an anode-supported solid oxide fuel cell comprising an anode support layer including an oxygen ion-conducting structure suitable for solid oxide fuel cell use and with a plurality of vias extending through the thickness of the oxygen ion-conducting structure. At least some of the vias are filled with electronically conductive material. An anode functional layer is in adjacent intimate contact with the anode support layer and an electrolyte layer is in adjacent intimate contact with the anode functional layer. A cathode layer is in adjacent intimate contact with the electrolyte layer.

Shibata neither discloses nor suggests an anode support layer as recited in amended claim 12. The base body 1 of Shibata simply cannot be said to correspond to the recited anode support layer since an alumina ceramic is not an oxygen ion-conducting structure suitable for solid oxide fuel cell use. Simply because an alumina ceramic exhibits some ion conductivity does not make such an alumina ceramic an ion-conducting structure. Alumina's resistivity is too high for this material to be considered a solid electrolyte and an oxygen ion conductor suitable for use in a SOFC and the resistivity is also too high at SOFC operating temperatures to carry out the function of an SOFC electrode.

For all these reasons, the combination of elements recited in amended claim 12 is allowable.

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The present patent application is in condition for allowance. Favorable consideration and a Notice of Allowance are respectfully requested. The Examiner is requested to contact the undersigned at the number listed below for a telephone interview if, upon consideration of this amendment, the Examiner determines any pending claims are not in condition for allowance. The undersigned also requests the Examiner to direct all future correspondence to the address set forth below in the event the Examiner shows a different correspondence address for the attorney of record.



Respectfully submitted,

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Attachment 1

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*super-
ionic
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PRINCIPLES
AND
APPLICATIONS

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CHAPTER 2

Superionic Materials and Structures

Superionic solids are ionic materials with high electrical conductivity comparable with those of liquid electrolytes. These materials are also termed "solid electrolytes" or "fast ion conductors". Typically a superionic solid has the following characteristics:

- (i) crystal bonding is ionic;
- (ii) electrical conductivity is high ($10^{-1} - 10^{-4} \text{ ohm}^{-1} \text{ cm}^{-1}$);
- (iii) principal charge carriers are ions which means that the ionic transference number (t_{ion}) is almost equal to 1 (here t_{ion} refers to the fractional contribution of the ionic conductivity to the total conductivity);
- (iv) the electronic conductivity is small; generally materials with electronic transference number (t_e) less than 10^{-4} are considered satisfactory superionic solids.

The values of electrical conductivity of a few ionic and superionic solids are shown in Figure 2.1. The highest conductivity at room temperature obtained so far is for RbAg_4I_5 which is $0.27 \text{ ohm}^{-1} \text{ cm}^{-1}$. This is many orders of magnitude higher than those of the more commonly known ionic solids KCl , NaCl etc. which have room temperature conductivity $\sim 10^{-12} - 10^{-16} \text{ ohm}^{-1} \text{ cm}^{-1}$. It may be noted that most of the superionic materials attain a high electrical conductivity above a certain temperature which may or may not be well defined. In other words, with increasing temperature the electrical conductivity sometimes changes gradually (as in β -alumina) or shows an abrupt jump (e.g. in β - AgI , RbAg_4I_5 etc.). Furthermore, for the latter materials the abrupt conductivity change is sometimes associated with a distinct structural change (like the $\beta \rightarrow \alpha$ transition in AgI) but sometimes this is not so clear (as in RbAg_4I_5). Structures which allow fast ion transport are generally disordered, "channelled" or "layered" (Wiedersich and Geller 1971). Ion-Ion interactions or correlation

over, Owens (1971) has noted that M^+ ions with volumes greater than $85(\text{\AA}^3)$ do not generally form conductive compounds. Furthermore, for bigger cations a lesser amount may be needed. For example, the maximum conductivity is obtained with 13 mole % MI for the $(\text{CH}_3)_4\text{NI}-\text{AgI}$ system, 12.5 mole % in the $(\text{CH}_3)_2(\text{C}_2\text{H}_5)_2\text{NI}-\text{AgI}$ system and 12 mole % in the $(\text{C}_2\text{H}_5)_4\text{NI}-\text{AgI}$ system. This means that the percentage of added cations decreases with its increasing size as is expected from Raleigh's picture.

The above structural principles have been deduced on the basis of the very small amount of available structural data — mostly on cation substituted systems. More structural studies would be necessary both on anion and cation substituted systems to arrive at a better understanding.

2.8 Oxygen ion conductors

The first solid oxide electrolyte ever used was probably the ceramic with composition 85 wt % ZrO_2 , 15 wt % Y_2O_3 which was used by Nernst (1899) as an incandescent lighting material. Later Baur and Preis (1937) used this material for a fuel cell. The definite conductivity mechanism in terms of oxygen vacancies was proposed by Wagner (1943) and later verified by Hund (1952). However, the sudden increase of scientific interest in such materials started after Kiukola and Wagner (1957a, 1957b) illustrated their use in high-temperature thermodynamic measurements and fuel cells. In principle, almost all oxides can be expected to show some degree of oxygen ion conduction particularly the non-stoichiometric oxides. The non-stoichiometry can be created by heating the metal oxides in vacuum or oxygen or the relevant metallic vapour (Wagner 1974). Most of the oxygen ion conductors are good only at high temperatures ($\sim 1000^\circ\text{C}$) and are mixed conductors (ionic + electronic + electron-hole). As in the case of other ionic conductors, the conductivity in this case is strongly dependent on the temperature and doping with aliovalent impurities (like Ca^{2+} , Y^{3+} , Sr^{2+} etc. in HfO_2 , CeO_2 etc.) which control the number of point defects and their mobility. However, a unique property of oxide conductors is the dependence of the conductivity on the ambient pressure or activity. If the ambient oxygen pressure is low, the oxygen ions (O_O) would leave the solid electrolyte according to the following mechanism†:

† The defects are expressed in the Kröger-Vink notation: the symbol indicates the defect; the subscript the location of the defect; and the superscripts (') (•) denote negative and positive charges respectively. For example $V_\text{O}^{\bullet\bullet}$ means vacancy at the oxygen site having effectively two positive charges. Similarly, $\text{O}_\text{i}^{\prime\prime}$ would indicate an oxygen ion at the interstitial site with effectively two negative charges.

tions, cooperative hopping or correlation effects play important roles. Details of the conductivity mechanism will be discussed in Chapter 4. Figure 2.46 gives a schematic plot of conductivity as a function of partial pressure of ambient oxygen for a typical oxide electrolyte at three different temperatures. The higher the temperature, the lower is the range of oxygen pressure over which the conductivity is ionic. The dependence of the range of ionic conduction on concentration of aliovalent dopant (like Ca^{2+} or Y^{3+}) is shown in Figure 2.47. The effect of increasing concentration is to broaden the range of ionic conductivity and shift the whole conductivity curve to lower p_{O_2} values.

Most of the useful oxide electrolytes developed so far are based on ThO_2 , CeO_2 , HfO_2 and zirconia, though some other systems have also been described. For an earlier review see Etsell and Flengas (1970). The common structure which sustains high oxygen ion conduction is the "fluorite structure". The fluorite structure for MO_2 (M = metal ion Th, Ce etc) is shown in Figure 2.48. In this structure there are a large number of octahedral interstitial voids. Each metal cation is surrounded by eight

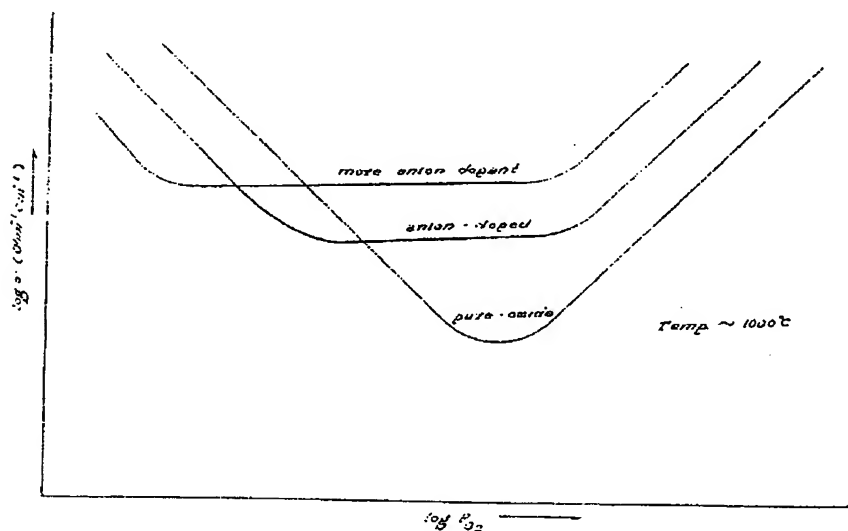


Fig. 2.47 Schematic representation of the dependence of conductivity of any oxide ion electrolyte on oxygen partial pressure for samples doped with different concentrations of aliovalent anion (Ca^{2+} , Y^{3+} etc.).

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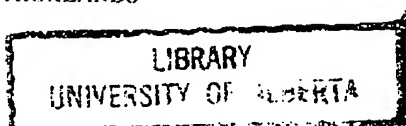
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Attachment 2

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MATERIALS SCIENCE
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THIRD EDITION

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and
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Electrical Properties**Table 291. RESISTIVITY OF CERAMICS**

(SHEET 4 OF 6)

Class	Ceramic	Resistivity (Ω -cm)	Temperature Range of Validity
Oxides	Aluminum Oxide (Al_2O_3)	$>10 \times 10^{14}$	25°C
		2×10^{13}	100°C
		1×10^{13}	300°C
		6.3×10^{10}	500°C
		5.0×10^8	700°C
		2×10^6	1000°C
	Beryllium Oxide (BeO)	$>10^{17}$	25°C
		$>10^{15}$	300°C
		$1-5 \times 10^{15}$	500°C
		$1.5-2 \times 10^{15}$	700°C
		$4-7 \times 10^{15}$	1000°C
	Magnesium Oxide (MgO)	1.3×10^{15}	27°C
		$0.2-1 \times 10^8$	1000°C
		4×10^2	1727°C
	Silicon Dioxide (SiO_2)	10^{18}	room temp.
	Zirconium Oxide (ZrO_2)		
	(stabilized)	2300	700°C
	(stabilized)	77	1200°C
	(stabilized)	9.4	1300°C
	(stabilized)	1.6	1700°C
	(stabilized)	0.59	2000°C
	(stabilized)	0.37	2200°C

Source: data compiled by J.S. Park from No. 1 Materials Index, Peter T.B. Shaffer, Plenum Press, New York, (1964); Smithells Metals Reference Book, Eric A. Brandes, ed., in association with Palmer Research Institute Ltd. 6th ed. London, Butterworths, Boston, (1983); and Ceramic Source, American Ceramic Society (1986-1991).

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Attachment 3

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Summary of Comments on Steele

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editorial review articles

Materials for fuel-cell technologies

Edman C. H. Stubs* & Arge Eke Heltzell†

Einige der besprochenen Ereignisse der Weltgeschichte haben auch Auswirkungen auf die Politik der Bundesrepublik Deutschland. Ein Beispiel hierfür ist die Entwicklung der Energiepolitik. Die Bundesregierung hat sich verpflichtet, den Anteil erneuerbarer Energien an der Stromerzeugung zu erhöhen. Dies ist eine direkte Folge der internationalen Abkommen und der politischen Entscheidungen der letzten Jahre.

[illegible]

The sheer cost of transportation of a ton of electricity has deterred attempts to use positive and negative energy storage technologies for more than a few years ago. However, in the wake of the airline system efficiency and cost-cutting measures, environmental lawyers, with their well-known penchant for litigation, have pressed difficult to develop the early-stage experiments that common law would mandate. These problems have common law made it difficult to lack of appropriate standards of measuring values. The common law would enable the cost of electricity for a kWh to be compared with the existing disbanding, as outlined in a sample case.

The types of cells with early embryonic origin are summarized in Fig. 1. The pluripotent (EC) and multipotent (EPC) cells are derived from embryonic, extra-embryonic (EC, EPC) and adult (APC) cells. These cells can self-renew and differentiate into all cell types. The pluripotent (EC) and multipotent (EPC) cells can be used to generate all cell types. The pluripotent (EC) and multipotent (EPC) cells can be used to generate all cell types.

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varies considerably in the factors influencing the measurement of the effect.

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Another selection for a consumer product line is the use of technology processes that are easily transferred to the entire production operation. However, it is possible to use a technology that is not used throughout the whole plant and still use the associated asset flexibility. For example, in a cell, a dedicated asset-specific robot is used in a cell to process parts (such as end effector gripper) which are not produced in the plant. This robot is not used in the plant, but it is used in the cell. This is a good example of a technology that is not used throughout the whole plant and still use the associated asset flexibility.

The present study was designed to compare the effects of the two treatment modalities on the clinical and histological response to the treatment of the oral cavity. The aim of the study was to evaluate the effectiveness of the two treatment modalities in the treatment of the oral cavity. The study was conducted in a retrospective manner, using data from the medical records of the patients who had been treated with either of the two modalities. The data were analyzed using statistical methods to determine the significance of the differences between the two groups. The results of the study showed that the two treatment modalities were equally effective in the treatment of the oral cavity. There were no significant differences between the two groups in terms of the clinical and histological response to the treatment. The study concluded that the two treatment modalities are both effective in the treatment of the oral cavity, and the choice of treatment should be based on the individual patient's needs and preferences.

such as were used in the ASH of the electron microscope. Further improvements in polymerizer were indicated by the results of polymerizing small crystalline (model) and large (electrodeposited) platinum or silver particles in solution, as previously reported. In respect, this means that the polymerizer was probably the best modification of an electron microscope. It is to be hoped that this means that the polymerizer will be a useful tool in the future.

The high-molecular-weight (HMW) fraction of the polymeric material was fractionated by size exclusion chromatography (SEC) on a column of Waters Styragel HR5E (8 mm \times 30 cm) with a refractive index detector (RI) and mobile phase consisting of 0.1 M sodium acetate and 0.1 M sodium chloride. The flow rate was 1.0 mL/min. The eluent was collected in 1.0 mL fractions. The elution volume was determined by the retention time of a series of monodisperse polystyrene standards. The molecular weight of the polymer was determined by SEC with a calibration curve obtained from the retention times of the polystyrene standards. The molecular weight of the polymer was determined by SEC with a calibration curve obtained from the retention times of the polystyrene standards.

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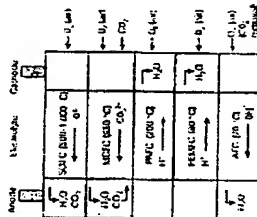


Figure 1 shows a typical I-V plot. The voltage window used in this plot is the typical range of the battery of interest. The linear portion of the plot is the ohmic region, $I = V/R$, where $R = 1/Z_{ohmic}$. The non-linear portion of the plot is the electrochemical region, $I = I_0 \exp(V/nRT)$, where I_0 is the exchange current density and n is the number of electrons transferred per molecule of the electroactive species. The current density I is related to the concentration of the electroactive species C by the equation $I = nFAC$, where n is the number of electrons transferred per molecule of the electroactive species, F is the Faraday constant, and A is the electrode area. The concentration of the electroactive species C is related to the concentration of the electroactive species C_0 by the equation $C = C_0 \exp(V/nRT)$, where C_0 is the concentration of the electroactive species at equilibrium. The concentration of the electroactive species C_0 is related to the concentration of the electroactive species C_0 by the equation $C = C_0 \exp(V/nRT)$, where C_0 is the concentration of the electroactive species at equilibrium. The concentration of the electroactive species C_0 is related to the concentration of the electroactive species C_0 by the equation $C = C_0 \exp(V/nRT)$, where C_0 is the concentration of the electroactive species at equilibrium.

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Additional constraints influencing material selection have been reliability and availability data. For transport applications, minimal values of performance and availability (for example, 0.1% over 1,000,000 h) are required for proposed operations of lifetimes of 8,000 h. For stationary applications — for example, distributed CHP (combined heat and power) systems — a similar degradation rate must extend over a period of at least 48,000 h (5 years). These different lifetimes targets seem to be limiting problems for PEMFC-powered CHP systems, as the stack components were developed to typically 60,000 h for stationary applications.

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Approximately current, on-order quantities (MnO₂-cathoded flat cells) are being converted to 200 kW. There have been failures around the world, but they have exhibited great reliability. However, the commercial future of this system is probably in jeopardy as the manufacturers (BPC and Japanese companies) have been unable to manufacture the capital cost sufficiently below US\$3,000 per kW, as originally forecast.¹ Most observers² believe that for flat-plate and tubular cells, the target cost of \$1,000 per kW, with volume production, will not be achieved until 1985-90 per kW, with volume production. Accordingly, we focus here on miniature aspects of the PbAgPC, PbAgPC-Pb, and SOFC systems, which at present still appear to present the greatest likelihood to exploit their potential.

It is important to note that the materials currently being used in PFC, MPFC and Indular SOFC prototype demonstrators have not significantly remained the same as those selected at least 25 years ago. Although numerous fabrication and processing routes have improved the attributes for, for example, lower cost and lower Pt loading of these catalysts, it is only within the last year that systems engineering and commercialisation issues have highlighted the consequences of some of the materials originally selected. As indicated in the next two sections, it is these issues that are now driving the development of alternative materials, particularly for the PIMFC and Intermediate Temperature (IT)-SOFC stacks.

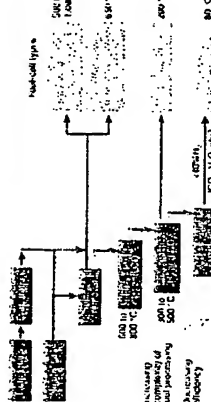
Advancing technology means that high tech. The most important materials under development for PEMFC stacks are composites from materials for the cell bases, bipolar plates, and electrolyte as for the fuel and oxid. electrolyte, and the heat conducting materials.

Depositing on the fuel to be used in the PEM cell, the requirements for these materials are completely different. The simplest case is the operation with pure hydrogen as a way to create cells with high

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Figure 1 illustrates the structure of a bipolar plate. The bipolar plate is a thin, flat, rectangular component that serves as a separator between the anode and cathode compartments of a fuel cell. It is typically made of a conductive material, such as graphite or a metal alloy, and is coated with a thin layer of catalyst. The bipolar plate is designed to distribute the reactants (hydrogen and oxygen) evenly across the surface of the catalyst and to collect the products (water and carbon dioxide). It also provides mechanical support for the catalyst and helps to maintain the proper temperature and humidity for the reaction.



Important R&D report. However, an operation temperature above the melting point of water requires a completely different type of bipolar plate material. In this regard, the bipolar plate must still be present under these conditions to maintain the integrity of the fuel cell structure.

Which effort is being expended on the development of such-off-the-shelf bipolar plates? With respect to corrosion resistance, graphite materials are preferred. However, the conductivity of graphite materials is much less than that of metallic materials. Some conductive values are: Carbon: 10^4 S/cm; Graphite: 10^3 S/cm; Steel: 10^6 S/cm; Titanium: 10^6 S/cm; Inconel: 10^6 S/cm; Copper: 10^6 S/cm; Aluminum: 10^6 S/cm. The bipolar plate must also be able to withstand the corrosive environment of the fuel cell. The bipolar plate must also be able to distribute the reactants evenly across the surface of the catalyst and to collect the products. The bipolar plate must also be able to maintain the proper temperature and humidity for the reaction.

Another way to use metallic bipolar plates is to use a thin layer of a corrosion-resistant material on the surface of the plate. This can be done by electroplating or by using a thin layer of a corrosion-resistant material. The bipolar plate must also be able to withstand the corrosive environment of the fuel cell. The bipolar plate must also be able to distribute the reactants evenly across the surface of the catalyst and to collect the products. The bipolar plate must also be able to maintain the proper temperature and humidity for the reaction.

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Author: sarkar
Subject: Highlights
Date: 07/2/2008 1

Author: eamk
Subject: High light
Date: 9/22/2008

Insight review articles

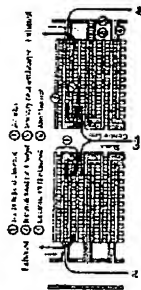


Figure 3 shows a cross-section of the Siderite from mine. The matrix is made of typical strombolite. Small (~ 5 mm) strombolite are visible in the matrix. The strombolite are composed of small, stable jets of gas that are emitted from the central vent of the strombolite and are surrounded by a thin layer of gas. The strombolite are surrounded by a thin layer of gas. The strombolite are surrounded by a thin layer of gas.

with the reduction and oxidation of the Ni component. As the amount of surface, electrically active Ni increases, so does the amount of Ni^{2+} released. It is possible that the Ni^{2+} released is due to the loss of the metal during the initial heating cycle in the conventional vanadium redox cell. The Ni^{2+} released from the Ni/NiO electrode in the vanadium redox cell is not due to the loss of the metal during the initial heating cycle, but is due to the loss of the metal during the initial heating cycle in the vanadium redox cell. The Ni^{2+} released from the Ni/NiO electrode in the vanadium redox cell is not due to the loss of the metal during the initial heating cycle, but is due to the loss of the metal during the initial heating cycle in the vanadium redox cell.

Also, TEGSR-covered fibers are much smaller (typical radius, 0.05 μm) than the 12.5 μm diameter of the bare fiber. This size difference may be due to the fact that the TEGSR-coated fibers are prepared by spin coating, whereas the bare fibers are prepared by extrusion. The smaller size of the TEGSR-coated fibers may be beneficial for applications in which the fiber is used as a waveguide or as a component in a photonic device.

[illegible]

the 1990s, when the number of cases was estimated to be 100,000-150,000 annually, and the number of deaths was estimated to be 100,000-150,000 annually.

[illegible]

Another signal is that the free-radical equivalent of the attractive forces of CH_3I and SO_2 leads to the need for a very different, much more complex, free-ion theory to explain the observed temperature dependence of the rate of reaction of these free radicals with CH_3I and SO_2 , and these are undoubtedly of great importance to the study of the kinetics of free-radical reactions. The free-radical theory for conjugate radicals can be elaborated which yields much better predictions at 500°C . (for example, $0.15 \times 10^4 \text{ cm}^3 \text{ mole}^{-1} \text{ sec}^{-1}$ for conjugate anion such as N_2CH_2) for simple aliphatic radicals at 500°C . for structural types like CH_3 , indicating that $10^{-10} \text{ cm}^3 \text{ mole}^{-1} \text{ sec}^{-1}$ are now a valid limit.

Opinion is a controversial topic, and it is important to consider the implications of the different views. Some people believe that the current system is the best, while others believe that it needs to be changed. The evidence is mixed, and the decision is ultimately up to the voters.

of the liquid. The authors of the present study have shown that the thermal expansion coefficient of G350 and ferritic steels are very similar, about $(2.5 \times 10^{-6} \text{ K}^{-1})$, so that the thermal expansion of the liquid and the solid is similar. This is in contrast to the liquid and solid of polymers, where the thermal expansion of the liquid is much greater than that of the solid. This result supports the PHE structure as a model, and should allow the rapid temperature response of the liquid to be used for the design of a PHE.

and/or hydrogenated lipid (LH), (LH:PC), and also attracting attention to the use of PC as a lipid carrier for the administration of hydrophobic drugs (Fig. 1) than CECG of 200°C. These data demonstrate that the lipid is totally more appropriate to use as the lipid carrier for the administration of hydrophobic drugs than CECG of 200°C, whereas the reduction of C₁₈ in CECG at 200°C is not observed. These results suggest that the reduction of C₁₈ in CECG at 200°C is not observed, and the reduction of C₁₈ in CECG at 200°C is not observed.

[illegible]

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Attachment 4

4

Spar Plug use alumina since it is electrically insulator:

<http://vshsp.en.alibaba.com/search/offer>

Auto Ignition System use alumina since it is an insulator:

<http://starsparkplug.en.alibaba.com/offerlist.html>

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Page 8 -shows use of alumina tube in an assembly as a Insulator:

Henry Rohrs poster

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Goodfellow- a table listing volume resistivity of alumina >10¹⁴ ohm-cm.:

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